



U.S. Department
of Transportation
**Research and
Special Programs
Administration**

Memorandum

U.S. DEPT. OF TRANSPORTATION

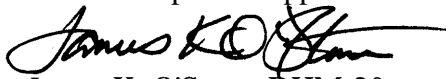
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Date: January 12, 2000

Reply to Attn. of:

Subject: A White Paper on Opportunities for Improved Incident Reporting

From: 
James K. O'Steen, DHM-20

To: Docket No. RSPA-99-50 13⁴⁸ (HM-229) Revisions to the Incident Reporting Requirements and the Detailed Hazardous Materials Incident Report DOT Form F 5800.1

On August 24, 1999, I participated in a meet sponsored by the Transportation Research Board Committee on Hazardous Transportation (Committee) on opportunities to improve hazardous materials incident reporting in support of hazardous materials transportation risk management. The meeting was held at the Transportation Research Board Headquarters in Washington, D.C. and facilitated by Dennis Ashworth from Chevron Chemical Company. Mr. Ashworth summarized the ideas discussed during the meeting into a paper titled "A White Paper on Opportunities for Improved Incident Reporting" and circulated it to Committee members and friends for comment. On January 10, 2000, at a meeting of the Committee a final version of "A White Paper on Opportunities for Improved Incident Reporting" was discussed and accepted by the Committee.

I am placing this memorandum and a copy of the white paper into Docket No. RSPA-99-50 13 (HM-229) to document my participation in these discussions and to input the ideas contained in this paper into the decision making process on this docket. See Attachment 1, A White Paper on Opportunities for Improved Incident Reporting. Also see Attachment 2, for a list of the attendees at the August 24, 1999, meeting. Please note that most members of the Committee are industry, government or academic professionals with responsibilities for analyzing or managing transportation risk. #

Hazardous Materials Transportation Incidents

A White Paper on Opportunities for Improved Reporting

Introduction

This document is a product of a meeting held in Washington, D.C. in August 1999 at the Transportation Research Board Headquarters on Wisconsin Ave. Attending this meeting were representatives of chemical manufacturers, truck and rail carriers, US DOT Research and Special Programs Administration (RSPA), Transport Canada, US DOT Bureau of Transportation Statistics, Chemical Manufacturers Association, and the Association of American Railroads. The meeting was sponsored by the TRB Committee on Hazardous Materials Transportation and facilitated by Dennis Ashworth from Chevron Chemical Company. The meeting was prompted by RSPA's Advanced Notice of Proposed Rulemaking [Docket No. RSPA-99-5013 (HM-229)] Hazardous Materials: Revisions to the Incident Reporting Requirements and the Detailed Hazardous Materials Incident Report DOT Form F 5800.1. This paper summarizes the ideas discussed during the meeting and the organizations and companies that participated do not necessarily support all of the ideas detailed here.

Executive Summary

Enhanced incident reporting opportunities for improved: distribution risk management, root cause analysis, and implementation of preventative measures are suggested as follows:

- Make reporting of the root cause of each **hazmat** incident a requirement including a descriptive field where preventative actions can also be documented.
- Require enhanced reporting of environmental conditions (weather, road/track conditions).
- Enhance documentation/reporting of the extent of damage to packagings to include:
 - the location of the damage;
 - what caused the damage;
 - the age of the container;
 - the specification of the container;
 - what special safety appliances/equipment did the container have; and
 - a mechanism for reporting packaging successes whereby hazardous materials were successfully contained within the container despite potential major or minor transportation events.
- Provide data on operator experience and training.
- Include data on any mode or route-specific operations that might have influenced the event including data on road/track-types and speed.
- Include information on the number of packages involved in each **hazmat** incident and the number of the packages that failed as a result of the incident.
- Provide greater clarification of who specifically is required to submit **hazmat** incident reports during a material's transportation from origin to final destination.
- Develop a method whereby higher consequence incidents are given greater attention **and/or** greater in-depth reporting requirements.
- Provide a mechanism to gain an understanding of the importance of the media and public concern for each incident.

- Report on all road, rail, and waterway closures for **hazmat** incidents, the length of the closures and their impact on the public and commerce.
- Gain an understanding and report on all evacuations, the type of people evacuated, their duration, and the effects on the personnel evacuated.
- Consider requiring reporting of all rollovers, major collisions, barge **groundings**, and derailments in which hazardous material was being transported, but in which there was not a **hazmat** release (perhaps consider a dollar threshold for these type of reports).
- Provide data on environmental and property damage associated with **hazmat** incidents including projected or actual dollar costs.
- Provide enhanced data on the percent of lading lost during **hazmat** incidents, the container capacity, and the total amount shipped in each container involved in a **hazmat** incident.
- Require information on the specific causes of incidents and the consequences of each cause.
- Provide details on mitigation including what specific action was taken and the time required to stop any release if applicable.
- Report on the amount of material released and the fate/distribution of the material released.
- Clarify of who must file incident reports (a typical example pertains to what is defined as interim storage in which many major bulk chemical storage terminals do not feel they are required to report **hazmat** releases under the interim storage definition – an additional example pertains to who is required to file a report when a “shipper” is filling a **railcar** and has an unintentional release prior to releasing the car to a railroad).
- Include sections in the incident report to provide for detailed narratives that would allow the author to explain the details of a particular incident.
- Require hazardous materials incident reports consistently across all modes of transportation including bulk marine (without bulk marine included, industry has no way of accurately comparing the transportation risk across all major modes of transport).
- Develop linkages to local police and fire reporting databases to gain access to greater amounts of incident detail.
- Adopt consistent commodity nomenclature – for example, the use of the hazardous material proper shipping name and identification number should always be required.

Background

The elimination of transportation incidents involving hazardous materials shipments is a goal embraced by shippers, carriers, regulators, package manufacturers, and researchers. Progression toward this goal will provide ever increasing protection of the public and the environment from the potential dangers associated with the release of hazardous materials resulting from a transportation incident. While great progress has been made in improving the safe transportation of hazardous materials within the United States, the more than 13,000 incidents reported each year to the Department of Transportation suggests that significant improvements can be made.

Improvements in the safe transport of hazardous materials benefit the public, the environment, and industry. According to DOT statistics for the highway, rail and air modes of transportation, each year more than 150 persons are injured as a direct result of hazardous materials transportation incidents. This is unacceptable. While the workers involved in the manufacture and transport of hazardous materials generally understand the potential risks associated with these materials, the public does not and should not be expected to accept these risks or injuries.

Annual damages associated with hazardous materials transport incidents are typically in the tens of millions of dollars. While the U.S. has strong programs in place to ensure that environmental damage resulting from these incidents is repaired, this is not always possible. Furthermore, assessing the environmental damage resulting from some hazardous material incidents is very difficult and short and/or long-term **remediation** may not always be possible.

Today's modern world relies on many, if not most, of the products derived from hazardous materials produced around the world. Products such as medicines, carpet, electronics, and clothing are all derived initially from hazardous materials. In addition, consumer products such as gasoline for our cars and natural gas to heat our homes are hazardous materials that would be very difficult to live without. Because of the importance of these materials, the public gives industry the right to produce and transport these materials due to the benefits derived from them. However, should transport incidents associated with these materials continue to rise, the right to produce and transport these materials could be greatly restricted.

As we move into the new millennium, government, academia, and industry are working hard together to make further gains in the safe transport of hazardous materials. It is a time of gaining a better understanding of each other's procedures, goals, and mandates so that the best each can offer can be exploited for the benefit of the public and the environment. From the government, the hazardous materials transportation regulations have provided a very effective method for controlling how hazardous materials are transported in commerce. As the regulations continue to evolve, the cooperation of the government with academia and industry, to understand which regulations are most effective and which are not, has brought on a great sense of cooperation and teamwork. From industry groups such as the Association of American Railroads and the Railway Progress Institute, these organizations continue to strive to identify the most appropriate containers for transporting hazardous materials by rail within the U.S., Canada, and Mexico. And from industry, initiatives such as Responsible Care[®] are driving chemical manufacturers and carriers to improve their distribution operations through the use of distribution risk management and accident investigation processes to correct and/or help prevent potential transport problems.

The Department of Transportation's Research and Special Programs Administration recently proposed revising the requirements for hazardous materials incident reporting including an evaluation of potential improvements to the reporting Form F 5800.1 Hazardous Materials Incident Report. As the primary tool for gathering data on the magnitude and nature of hazardous material incidents within the United States, this review is an opportunity to further enhance our knowledge of:

- the distribution risk associated with hazardous materials transportation,
- the reasons why hazardous material incidents occur,
- the root cause(s) of these transportation incidents, and
- the directions which should be pursued to prevent these type of incidents from occurring in the future.

Distribution Risk

Hazardous materials distribution risk can be defined as the probability of a transportation incident occurring that may harm the public or the environment due to release of the material from its transport container. Materials classified as hazardous are defined as materials possessing a significant enough acute hazard such that special transport regulations and procedures must be followed. Therefore, all hazardous materials can be assumed to possess properties such that, if released, a higher level of danger will exist than for a material not classified as a hazardous material.

To evaluate the risk (potential for harming the public or environment) associated with transporting hazardous materials; two critical pieces of data are required:

- what is the probability that a hazardous material will be involved in an transportation incident; and
- what is the probability that the material involved in the transportation incident will be released from its transport container.

While it is true that different hazardous materials possess varying degrees of danger to the public and environment, it is only after an incident and a release has occurred, that the properties of the material come into play. Therefore, if it is agreed that the goal is to prevent/reduce all hazardous materials transportation incidents, the focus must be placed on understanding and reducing the two probabilities bulleted above.

Industry and many others studying distribution risk rely on the following equation to calculate the probability of a hazardous materials transportation release for a specific material being transported from a specific origin to a specific destination:

$$\text{Release Probability} = \text{Miles/Trip} \times \text{Trips/Year} \times \text{Accidents/Mile} \times \text{Releases/Accident} = \text{Releases/Year}$$

Use of the above equation to calculate the releases/year to be expected for an MC307 tank truck transporting a hazardous material from Houston to Chicago are shown below in Example 1:

$$\begin{aligned} \text{Example 1: } & 1089 \text{ miles/trip} \times 309 \text{ trips/year} \times 2 \times 10^{-6} \text{ accidents/mile} \times .04 \text{ releases/accident} \\ & = .027 \text{ releases/year or 1 release every 37 years} \end{aligned}$$

For the movement of the same volume of material by rail (111 A, no headshields), the expected releases/year can be calculated as shown in Example 2:

$$\begin{aligned} \text{Example 2: } & 1089 \text{ miles/trip} \times 103 \text{ trips/year} \times 5 \times 10^{-7} \text{ accidents/mile} \times .18 \text{ releases/accident} \\ & + 3 \text{ switch yards/trip} \times 1 \times 10^{-4} \text{ accidents/yard} \times .03 \text{ releases/accident} \times 103 \text{ trips/year} \\ & = .011 \text{ releases/year or 1 release every 91 years} \end{aligned}$$

In each of the above examples, the expected number of releases per year is dependent upon the number of trips/year, the distance, the accidents/mile for each mode, and the release probability for each container type. The first two pieces of data, distance and trips per year, are easily obtained and with a high degree of accuracy.

The last two data elements, accidents/mile and release probability, are extremely important in evaluating modal choices, container specifications, and whether a movement is of acceptable risk. Furthermore, in example 2, the result is dependent upon not only the accuracy of the rail accidents/mile and the release probability but the switch yards accident rate and release probability.

To achieve accurate assessments of the distribution risk associated with hazardous materials transportation requires a sound foundation of knowledge of many factors including typical accident rates/mile for the various modes of transportation, and the release probabilities of various specification containers given an accident. For both of these data requirements, information reported to the Department of Transportation Research and Specials Programs Administration, on Hazardous Materials Incident Reports, is of critical importance. This information; for highway, rail, and air, includes, but is not limited to; numbers of hazardous materials incidents for various modes of transportation and

specifications of containers, and the number and magnitude of releases from hazmat containers involved in accidents. This information unfortunately is currently not reported to RSPA for bulk marine transportation.

Returning to the two examples shown above, it is important to appreciate the effect errors in accident rates and release probabilities can have on risk-based decision making. In the above examples, a company attempting to determine which mode of transportation has the lowest risk for this particular movement would have selected the rail option. This would have been based on the chance of a significant rail incident calculated to be only once every 91 years versus the calculated truck probability of once every 37 years. However, had the truck accident rate been found to be in error and the actual rate have been the same as for rail (5×10^{-7}), then the calculated truck release probability would have been:

$$1089 \text{ miles/trip} \times 309 \text{ trips/year} \times 5 \times 10^{-7} \text{ accidents/mile} \times .04 \text{ releases/accident} \\ = .007 \text{ releases/year or 1 release every 148 years}$$

Therefore, it is of very considerable importance that industry, government, transportation planners, and researchers have accurate accident rates and release probabilities upon which to base important decisions effecting the safety of the public and the environment. This will allow correct risk-based decisions to be made in deciding modal and route choices, appropriate new safety regulations, and the design and transportation options for new transportation systems particularly through heavily populated areas.

One final area that is of equal importance to the numbers of accidents (numerator) for various transportation modes, routes and conditions is the denominator part of the equation. Completion of the equation for the “miles” component of the accidents/mile ratio requires data on the total hazmat miles per year for the various modes of transport. The U.S. D.O.T.’s Bureau of Transportation Statistics, in partnership with the Bureau of the Census as part of its Commodity Flow Survey, is currently working on providing improved denominator data. While clearly one can strive to achieve very specific accident/mile data for various types of roads, rail track class, time of day, speeds, etc., a general accident rate for the various modes of transportation is a significant goal that many will find highly desirable.

Root Cause Analysis & Implementation of Preventative Measures

An understanding of the distribution risks associated with various modes, routes, and containers is of critical importance when making transportation decisions. Of equal importance to industry and regulators is an understanding of why hazmat accidents occur and what can be done to prevent them in the future. Once again, this information can be derived from thorough incident reporting.

Generally, every hazmat transportation incident will have one to perhaps two or three factors that caused the incident to occur. Quite often more focus is placed on responding to the incident and filling out all required forms than conducting a detailed root cause analysis. However, it is in this analysis where common themes as to why incidents occur can be found. Common themes such as poor operator training, poorly designed gaskets or manways, faulty valve assembly and/or inspection, and lack of preventative maintenance can all be assigned to hundreds of, what might appear to be, unrelated incidents.

Knowledge of root causes of incidents provides very valuable data to shippers, carriers, package manufacturers and regulators. For industry, root cause analysis can point deficiencies in operating

procedures, training programs, routing decisions, or service provider quality. To obtain this data, industry must be prepared first to have a thorough reporting system in place so that details on each incident can be gathered and interpreted. For **hazmat** shippers, this data may often only be available from transportation service providers. Once this data is obtained, shippers and carriers must be prepared to invest the time to dig into the details of the incident to truly understand the root cause of the incident. It is important to note that, without data, no progress can be made. Therefore, it is important that **all** providers of incident data be given positive reinforcement for their incident reporting efforts.

Historically, situations have existed in which, if a carrier reported to a shipper that the carrier had caused a **hazmat** incident, the carrier was fired. This type of behavior will of course lead to carriers never reporting incidents. Instead, shippers need to thank the carriers for reporting and work with them to understand the true root cause of the incidents. With this approach, over time, a consistent data/incident reporting system will provide a foundation for uncovering trends and related root causes. Once a trend or consistent cause is uncovered, industry must be prepared to take proactive, strong action to implement preventative measures to eliminate the cause of the incident.

For regulators, once a consistent picture emerges of a particular problem area or trend, then steps can be considered to place additional requirements on industry to force a resolution to the problem area. Over time transportation systems change and steps may need to be taken to ensure ever-increasing safety for the public and the environment. Typical scenarios that might require regulatory intervention include: lack of sufficient training for shipping and transport personnel; the need for higher specification containers for various types of chemical products; or simply clarification or enhancement of existing regulatory requirements.

In summary, all incidents have a root cause as to why a particular incident occurred. By determining these causes and taking preventative actions to prevent future incidents, the risk associated with that particular transportation operation can be changed. The common element required for root causes analysis (leading to preventative measures) and distribution risk management is thorough consistent hazardous materials transportation incident data and reporting.

Opportunities

The current Department of Transportation Hazardous Materials Incident Reporting requirements provide considerable beneficial information that can be used for monitoring the effectiveness and identifying potential improvements in the safe transportation of hazardous materials. In its current form, the incident data provides a fairly consistent historical perspective on **hazmat** transportation incidents in the U.S. Because of this existing database, one should always be very careful in changing reporting thresholds and criteria such that a historical comparison would become **unmeaningful**. However, due to the great spirit of cooperation between government and industry, all parties recognize that there are opportunities to improve the reporting requirements so that future generations will have even better data upon which to base their **hazmat** transportation decisions and regulations.

Listed below are some suggestions that might serve to improve the current reporting requirements and reporting form to allow improved hazardous materials transportation risk management. The suggestions are grouped based on incident reporting enhancements that might be realized with respect to improving the understanding of: the CAUSE of **hazmat** incidents; the role of the CONTAINER in **hazmat** incidents; the role of OPERATIONS related events; SHIPMENT related data; the CONSEQUENCE of incidents; and overall REPORTING improvements.

CAUSE:

While generally all **hazmat** incidents eventually are resolved, with little or no damage to the environment or harm to the public, the goal is to prevent incidents from occurring in the first place. A timely response to a **hazmat** incident is of critical importance in minimizing the impact of the incident. Once the response and cleanup are complete, all reporting requirements must also be completed. Perhaps one of the most challenging, yet most important aspects of a **hazmat** incident, is working, often for weeks or months, to uncover the true root cause of an event. However, without this information, it is very difficult to put preventative actions into place to prevent similar future incidents. The primary opportunity for improved data on the cause of **hazmat** incidents is as follows:

- Make reporting of the root cause of each **hazmat** incident a requirement including a descriptive field where preventative actions can also be documented.
- In addition, require enhanced reporting of environmental conditions (weather, road/track conditions).

CONTAINER:

One of the early leaders in the distribution risk management field was a strong advocate of the fact that, “Regardless of how violent or terrible the factors might be in a hazardous material incident, if the hazardous material will stay inside its container, the material can not harm the public or the environment.” Therefore, improved knowledge of the successes and failures associated with hazardous materials packages is of great importance for future direction. Suggestions associated with container data include:

- Enhanced documentation/reporting of the extent of damage to packagings to include:
 - the location of the damage;
 - what caused the damage;
 - the age of the container;
 - the specification of the container;
 - what special safety appliances/equipment did the container have; and
 - a mechanism for reporting packaging successes whereby hazardous materials were successfully contained within the container despite potential major or minor transportation events.

OPERATIONS:

With over 80% of all **hazmat** incidents caused by human error, quite often these human errors occur during loading, unloading, storage, switching, or inspections operations. Therefore, two pieces of data that may lead to improved understanding of operations related factors are data on:

- operator experience and training; and
- any mode or route-specific operations that might have influenced the event including data on road/track-types and speed.

SHIPMENT:

Characteristics of the shipments of hazardous materials can contribute greatly to the probability of incidents. Data such as the number of shipments, distance, weather conditions, etc. all can play contributing roles. Another very important aspect relating to “Shipments” has to do with making sure

hazardous materials incident reports are submitted for every required incident. Failure of parties to understand their reporting obligations can lead to losses of critical data that ultimately distort the historical data integrity and validity. Two areas where it is felt that added information might be beneficial, over what is currently reported, include:

- information on the number of packages involved in each **hazmat** incident and the number of the packages that failed as a result of the incident; and
- greater clarification of who specifically is required to submit **hazmat** incident reports during a material's transportation from origin to final destination.

CONSEQUENCE:

Hazmat transportation incidents can hurt people and the environment. Understanding the consequences of these incidents can provide strong motivation for preventing future incidents. Furthermore, it is important to appreciate that it is the public that grants the **hazmat** transportation industry the right to move materials in commerce within the U.S. Should the public become more concerned over the consequences of **hazmat** incidents, that right could be diminished. Opportunities for gaining a better understanding of the consequences from **hazmat** incidents are:

- develop a method whereby higher consequence incidents are given greater attention and/or greater in-depth reporting requirements;
- understand the importance of the media and public concern for each incident;
- report on all road, rail, and waterway closures for **hazmat** incidents, the length of the closures and their impact on the public and commerce;
- understand and report on all evacuations, the type of people evacuated, their duration, and the effects on the personnel evacuated;
- consider requiring reporting of all rollovers, major collisions, barge **groundings**, and derailments in which a hazardous material was being transported but there was not a **hazmat** release (perhaps consider a dollar threshold for these type of reports);
- provide data on environmental and property damage associated with **hazmat** incidents including projected or actual dollar costs;
- provide enhanced data on the percent of lading lost during **hazmat** incidents, the container capacity, and the total amount shipped in each container involved in a **hazmat** incident;
- information on the specific causes of incidents and the consequences of each cause;
- details on mitigation including what specific action was taken and the time required to stop any release if applicable;
- details on the amount of material released and the fate/distribution of the material released.

REPORTING:

The current DOT reporting requirements under 49 CFR 171.16 provide the basis for the current, most comprehensive, **hazmat** incident reporting. These reporting requirements, along with the DOT Hazardous Materials Incident Report Form F 5800.1, have provided considerable data and information on hazardous materials transportation incidents within the United States. In response to HM-229, a number of groups have proposed improvements to the current reporting form. Of particular value may be the recommendation for "cause codes" which would force persons filing reports to categorize the incidents. This may lead to improved understanding of common root causes of incidents.

Suggested potential reporting improvements might also include:

- clarification of who must file incident reports (a typical example pertains to what is defined as interim storage in which many major bulk chemical storage terminals do not feel they are required to report **hazmat** releases under the interim storage definition – an additional example pertains to who is required to file a report when a “shipper” is filling a **railcar** and has an unintentional release prior to releasing the car to a railroad);
- sections in the incident report should be provided for detailed narratives that would allow the author to explain the details of a particular incident;
- hazardous materials incident reports should be required consistently across all modes of transportation including bulk marine (without bulk marine included, industry has no way of accurately comparing the transportation risk across all major modes of transport);
- linkages to local police and fire reporting databases should be considered to gain access to greater amounts of incident detail;
- consistent commodity nomenclature should be adopted – for example, the use of the hazardous material proper shipping name and identification number should always be required.

Conclusion

Complete, comprehensive, and accurate hazardous materials incident data is of critical importance for the continued improvement in the safe transportation of hazardous materials within the United States and internationally. For evaluating distribution risk, data on accident rates/mile for all modes of transport, allows the selection of routes, modes, and carriers with the lowest probability of an incident. Accurate data on container failures allows the calculation of release probabilities that are of critical importance in selecting the most appropriate container and protective features for transporting hazardous materials.

For root cause analysis, complete incident data provides the foundation for understanding what were the causes of an incident. And accurate incident data also allows one to determine the successes and failures associated with the implementation of preventative measures aimed at preventing future incidents.

While the reporting and collection of additional and/or enhanced data may represent an additional workload for those involved today, the value of the data (questioned by some) collected for future generations, may be well worth the additional effort. Because it is only after a number of years that data/incident trends can be uncovered, it is important that government, industry, and academia **hazmat** transportation professionals establish an improved foundation today, for the benefit of future decisions.

The **hazmat** transportation community should be proud of the great strides made in improving the safe transport of hazardous materials. Due to the low frequency of these events, the uncovering of incident trends, modal accident rate differences, and container releases probability differences is often challenging. This makes the accurate and thorough reporting of those existing and persisting incidents all the more important. By having **hazmat** incidents and releases consistently and accurately reported, we can all work together to make continuous strides forward in further improvements in the safe transportation of hazardous materials for the benefit of the public and the environment.

Attachment 2.

Attendees at the Meeting on Opportunities for Improved Hazardous Materials Incident Reporting, August 24, 1999, Transportation Research Board, Green Building, Washington D.C.

Dennis Ashworth – Chevron Chemical Company

Bob Worwood – Chevron Chemical Company

John Tichon – DOW Chemical

Bill Garfield – GATX

Richard McMahan – BNSF Railroads

David Hopps – Ryder

Mike Heimowitz – Chemical Manufacturers Association

Jim O'Steen – Research and Special Programs Administration, U.S. DOT

Raymond Auclair – Transport- Canada

Kim O'Grady – Transport Canada

Mark Lepofsky – Marasco Newton Group

Ron Duych – Duych Consultant